

## THE DEVELOPMENT OF HYDROELECTRIC POWER

In the early 1880s the first central power-generating station opened in New York City, and a plant in Appleton, Wisconsin, first utilized falling water in combination with a generator to produce electricity. Similar works opened in Minneapolis and at Niagara Falls, New York. New technology, such as the introduction of alternating current and advances in power transmission, followed. Rising industrial, municipal, and residential demands for this new energy source fostered the growth of power companies interested in potential profits. Earlier advances in dam materials and construction equipment made it possible to build the higher dams required for power production.

Soon private dam-building proceeded at a pace that threatened navigation, so the federal government stepped in. Congress began to regulate dams in the Rivers and Harbors Acts of 1890 and 1899. The legislation required that the Secretary of War and the Corps of Engineers approve the sites and plans for all dams and issue permits for their construction. Congress also required the developers to allow the United States to control a dam without making compensation "so far as shall be necessary for purposes of navigation." At any time the United States could require the owners to make changes in their dam to facilitate navigation. Between 1894 and 1906 Congress issued 30 permits for construction of private dams. The bulk of this power development was on the Mississippi River.

The Corps of Engineers' role also extended to assuring compliance with permits during construction. Much of this activity occurred at Niagara Falls. In the General Dam Act (1906), Congress standardized the regulations regarding private power development. Under this measure, when navigation facilities were required, the federal government could compel the owners to construct, operate, and maintain the facilities without compensation. If the United States built the facilities, the owners were required to contribute the necessary land and provide power to operate the facilities without charge. Ultimate title to the project remained with the United States.

Several fundamental views regarding hydroelectric power development emerged by the end of the first decade of the 20th century. One was that hydropower should be linked to a comprehensive plan for waterway improvement. Thus, a 1910 amendment to the General Dam Act required the Corps of Engineers to take such considerations into account when evaluating plans submitted for dam construction permits. Furthermore, Congress stipulated that all Engineer preliminary examinations and surveys--not just those relating to specific hydropower permits--must include information on how the development and utilization of hydropower for industrial and

commercial purposes would affect navigation and lessen the costs of navigation improvements. Hydropower, then, was seen as a factor in financing navigation and flood control projects involving dams. By including hydropower as part of a project built for another purpose, the overall cost of that project might be reduced. President Theodore Roosevelt expressed this view in 1903 when he vetoed a bill authorizing private construction of a dam and power stations at Muscle Shoals, Alabama. Private development, Roosevelt contended, would deprive the government of potential power revenues that might be used to offset navigation improvements in the area. Similarly, in another veto message Roosevelt stated that power revenues could pay all or part of navigation costs at a specific location and that any surplus could be applied elsewhere.

Of further importance for the future was the view expressed in the 1908 Preliminary Report of the Inland Waterways Commission that, unlike flood control and navigation, hydropower should yield a return that would cover "the cost of producing and transmitting . . . electric energy, including the amortization of the capital investment allocated to power over a reasonable period of years." The "reasonable period" has since been determined to be 50 years.

Prior to World War I, hydropower development remained in private hands under government regulation. The Corps did install a power station substructure as part of Lock and Dam 1 on the upper Mississippi River. After completing the dam in 1917, the government leased the power facility to the Ford Motor Company. Ford installed the equipment and began operations in 1924.

In response to the wartime need for nitrates to manufacture ammunition, the federal government finally began constructing a power facility at Muscle Shoals in 1918. President Woodrow Wilson chose Muscle Shoals because its waterpower potential was already well known. In February 1918 he approved construction of Dam #2, later known as Wilson Dam; an auxiliary power plant; and locks on the Tennessee River at Muscle Shoals. The Corps of Engineers took charge of the project. However, with the abrupt end of hostilities later that year, much of the support for the federal presence at the Shoals eroded. Throughout the 1920s a fierce debate over the project's future raged in Congress with Senator George Norris of Nebraska as the leading advocate of continued government ownership. Bills sponsored by Norris cleared Congress twice but were vetoed.

While the debate over retaining Muscle Shoals continued, the Corps of Engineers pushed forward with construction of Wilson Dam and the related facilities. By June 1923 the dam was 60 percent complete and the powerhouse 40 percent complete. Two years later both structures were substantially finished. Operations commenced on 1 April 1926, and the navigation locks opened the following year.

At the time it was completed, Wilson Dam was the world's largest masonry structure, a permanent monument to the Corps' engineering ability.

In the 1920s the investigations related to hydroelectric power development continued to be a significant part of the Corps' mission. At the beginning of the decade Congress created the Federal Power Commission (FPC) as the licensing agency for all nonfederal hydropower activity affecting or potentially affecting navigable waterways. At the time, it was estimated that under this criteria about 85 percent of remaining water power development would fall under FPC authority. Lieutenant Colonel William Kelly, a Corps officer, became the commission's first chief engineer. The FPC lacked its own field staff, so Kelly called on the Engineers to help examine applications, conduct field investigations and hearings, and prepare reports before licenses and permits were issued. Once an application was approved and a license granted, Corps officers along with engineers in the Departments of Agriculture and Interior helped superintend project construction.

The Corps' workload in support of the FPC was heavy. In fiscal year 1926 alone, the Corps made 48 examinations and reports for the FPC and supervised construction by 56 licensees. By 1931 the Corps had completed 276 engineering reports, held 69 hearings, and was overseeing 129 licensees.

Under the Federal Power Act the Corps constructed several dams in partnership with private companies. In such cases licenses were granted to develop the power components at navigation dams. The first project of this type, licensed in 1921, was at Green Island, New York, on the Hudson River. The Corps built the dam with the government providing a little more than \$1.4 million out of the total cost of about \$3.2 million. In exchange for its license and its own investment of about \$1.4 million, the private developer could sell the power and had to pay a yearly rental of \$5,000. Between 1921 and 1951, the FPC licensed nine similar projects. In some cases, even when no federal investment was involved, the license placed special requirements on the developer. For example, the City of Seattle got a license to build a dam on the Skagit River but was required to reserve a certain amount of storage capacity for flood control.

A dramatic change in Corps activities in the hydropower field began when Congress endorsed multiple-purpose planning in the Rivers and Harbors Act of 1925. Initially the Corps and the Federal Power Commission were to prepare cost estimates for surveys of navigable streams and tributaries "whereon power development appears feasible and practicable." The aim was a general plan to improve the navigation of the stream selected "in combination with the most efficient development of the potential water power, the control of floods, and the needs of irrigation." The Corps responded with a

recommendation for 24 surveys at an estimated cost of \$7.3 million. In 1927 Congress appropriated the funds for the studies, whereupon the Corps of Engineers launched its most comprehensive river survey to date. The resulting reports, submitted to Congress beginning in 1930, became known as the 308 Reports after the House document in which the survey estimates first appeared. The initial 308 reports, as later updated, became the basis for widespread multipurpose development undertaken by the federal government after World War II.

A shift in emphasis in federal hydropower development took hold during the New Deal. The Coolidge administration had fostered a policy of purposely producing surplus power at federal plants to provide funds for other projects. President Franklin Roosevelt viewed surplus power not just as a source of revenue to offset the costs of a particular project but as a means of providing cheap energy to a wide market. He also saw public works projects as a source of jobs in a time of economic depression and as an opportunity to put his power philosophy to a practical test.

During the New Deal, the Corps of Engineers participated in three major public works enterprises involving hydroelectric power: Bonneville Dam, Fort Peck Dam, and the Passamaquoddy Tidal Power Project. The Corps, for the first time since Wilson Dam, was engaged in building hydropower facilities. In 1933 Congress resolved the longstanding debate over Muscle Shoals when it created the Tennessee Valley Authority (TVA). The authority was charged with assuming broad responsibilities for administering Wilson Dam, constructing new dams and power plants, and marketing surplus power. In line with principles developed earlier, the TVA power projects were to be self-supporting and self-liquidating.

The Corps of Engineers completed the main dam and powerhouse facilities at Bonneville in 1937, but as work progressed Congress debated the issue of who would administer the facility. The result was the Bonneville Power Act signed by President Roosevelt on 20 August 1937. Under a compromise formula, the Corps of Engineers, which had built the dam, obtained the right to operate the dam and its power generators and to deliver the current to a substation. The act gave authority to dispose of the power and to set the rates to a civilian administrator under control of the Department of the Interior.

The Bonneville legislation directed that rates be set to encourage "the widest possible use of all electric energy that can be generated and marketed." In addition, the rates were to enable the government to recover the cost of producing and transmitting power, including amortization of the capital investment over a reasonable period of years. Power facilities were to benefit the general public, particularly domestic and rural customers. Furthermore, the Bonneville administrator was required to take the

steps necessary to transmit the available electric energy to existing and potential markets and "to interconnect the Bonneville project with other Federal projects and publicly owned power systems now or hereafter constructed." To carry out the purposes of the act, the power administrator was authorized "to acquire, by purchase, lease, condemnation, or donation, such real and personal property, or any interest therein, including lands, easements, rights-of-way, franchise, electric transmission lines, substations, and facilities and structures appurtenant hereto."

In later years the authority of the Bonneville Power Administration to market power expanded to include 32 additional federal projects. To carry out its marketing authority as effectively and efficiently as possible, by 1973 the power administration had constructed more than 13,000 miles of high voltage transmission lines. The Bonneville Power Administration services a seven-state area in the Pacific Northwest, where, as of 1973, it supplied 55 percent and transmitted more than 80 percent of the region's power.

As flood control became a primary purpose for constructing dams and reservoirs in the 1930s, hydropower potential was considered in relation to these projects. The Flood Control Act of 1938 included a provision "that penstocks or other similar facilities adapted to possible future use in the development of hydro-electric power shall be installed in any dam herein authorized. . . ." All subsequent legislation authorizing flood control projects included a similar provision.

The Flood Control Act of 1944 contained the first general provisions for the sale of power produced at Corps and other federal projects. The power generated was to be delivered to the Secretary of the Interior for disposal and transmission "at the lowest possible rates to consumers consistent with sound business principles." In selling established power, preference was to be given to public bodies and cooperatives. The pattern established with the Bonneville Power Administration was soon repeated as all federal power marketing, except for TVA projects, fell under control of agencies of the Department of the Interior. The agencies, in addition to the Bonneville Power Administration, were the Southeastern Power Administration, the Southwestern Power Administration, and the Alaska Power Administration (all under control of the Department of Energy since 1977), and the Bureau of Reclamation. The 1944 act again included the statement that "rate schedules shall be drawn having regard to the recovery . . . of the cost of producing and transmitting such electric energy, including the amortization of the capital investment allocated to power over a reasonable period of years."

The key to recovering costs has been the rate structure established by the power marketing agencies. The rates are based on recovery costs which include all applicable Corps of Engineers

reservoir costs, operation, maintenance, replacement, interest, and amortization. Under current practice, the power marketing agency in most cases markets the output of several projects together through a pooling arrangement. Thus, an individual project is not required to recover all of its own costs but may draw on revenues produced by other projects. The power administrations allocate revenues according to established priorities which place current year operations and ordinary maintenance costs first, followed by current year interest expense, prior operating deficits, and federal investment as the lowest priority. In paying back federal investment, the power marketers have given projects with higher interest rates their attention first. Thus some of the more recent projects show a higher percentage of costs recovered than older low interest projects.

Where provision is made for future installation of hydropower in accordance with the Flood Control Act of 1938, cost recovery procedures are less well defined. At projects already having initial power installation, like Chief Joseph Dam in the Pacific Northwest, all costs including future unit bays are recovered from present power revenues. At projects without initial power installations, however, the cost of provisions made for future power units is sometimes included as a joint-use cost with no recovery required.

As multipurpose projects blossomed after World War II, federal hydropower facilities expanded markedly. Congress authorized several new schemes on the Columbia and Snake rivers in the Pacific Northwest, and hydropower was part of comprehensive plans for the Missouri and Arkansas river basins. Between 1945 and 1959, initial power production occurred at 25 new sites. The bulk of these developments took place during the last six years of the period. If Congress refused to include power in the initial authorization, the continuing practice of installing penstocks at least made the introduction of power features possible in the future. Federal expenditures were not limited to construction. The Corps continued extensive 308 and FPC survey work.

During the Eisenhower administration, an attempt was made to trim federal expenditures. Goals were set early. In 1952 a Republican Study Group proposed slashing \$400 million from the budget for rivers and harbors, flood control, irrigation, and power projects between 1953 and 1957. New starts, according to the study group, should be limited to cases where defense needs were "clear and compelling." Private participation in power projects was deemed essential.

Promoting partnership arrangements was central to President Dwight D. Eisenhower's water resources policy. This approach seemed the only viable one because the federal government alone could not provide the \$96 billion investment projected in 1956 as necessary to

meet the nation's power needs for the next 20 years and because state and local resources could not afford to develop the complex projects required. In many ways the basis of this policy resembled that stated by Treasury Secretary Albert Gallatin in 1808: certain essential development would not occur unless the federal government took charge.

The Eisenhower partnership policy actually made little headway. Despite the administration's budget trimming goals, overall power development increased between 1953 and 1960. Installed capacity at all electric utilities rose 77 million kilowatts. Federally installed capacity doubled, from 11 to 22 million kilowatts. The quantity added by the Corps of Engineers, at existing and new projects, accounted for nearly 50 percent of the gain at federal facilities. In fiscal year 1958 alone, the Corps added 792,000 kilowatts at its multipurpose projects, a figure which represented 67.4 percent of the combined federal and nonfederal increase in hydropower capacity for that year.

During the 1960s and the 1970s, the Corps continued to expand upon the 27 projects with hydroelectric capabilities that it had built the preceding decade. Power was added at 17 multipurpose sites in the 1960s and planned at 20 new locations by 1980. The total electric output from Corps generators rose from 27.9 billion kilowatt hours in 1960 to 61.1 billion in 1970 and to more than 80 billion in 1975. The electricity generated at 53 Corps reservoirs in fiscal year 1970 represented 23 percent of the total U.S. hydroelectric power production for that year.

In statistics released by the Federal Power Commission in 1970, Corps hydroelectric power facilities represented the largest segment of installed capacity at federal hydroelectric projects (13,000 megawatts). Bureau of Reclamation and TVA projects accounted for all but a trace of the remaining 10,000 megawatts of installed federal hydroelectric capacity. While the Corps is the largest single producer of hydroelectric power and total federal hydroelectric power capacity nearly equals nonfederal hydroelectric capacity, the position of the federal government changes significantly when total electric energy capacity from all sources is considered. Hydroelectric power actually accounts for a small portion of total power capacity. Privately owned facilities clearly dominate the nonhydroelectric power field. For example, in 1970 power systems owned by private investors (at the time there were approximately two hundred major utilities) accounted for 77 percent of the nation's generating capacity and served 78 percent of the customers. The federal segment accounted for about 12 percent of capacity and 13 percent of output.

According to the Hoover Commission's 1955 report, out of the total \$14.3 billion federal investment in water resources development, \$3.9 billion was for hydropower. Of that amount \$1.4

billion was for Corps power and \$1.3 billion for TVA power. Figures provided in 1973 by the National Water Commission extended the period of consideration through 1968. By that time the cost of federally owned or financed hydropower development had climbed to \$9.3 billion (stated in 1972 dollars). This figure represented one-half of total expenditures for hydropower. State and local governments provided \$3.2 billion; private companies invested \$6.2 billion.